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09/819,296	03/27/2001	Wei Pan	SLA 0515	4061

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EXAMINER	
VU, HUNG K	

ART UNIT	PAPER NUMBER
2811	

DATE MAILED: 01/25/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/819,296	PAN ET AL.	
	Examiner	Art Unit	
	Hung Vu	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 April 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *8-10 and 12-25* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *8-10 and 12-25* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Request for Continued Examination

1 A request for continued examination (RCE) under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicants' submission filed on 04/29/03 has been entered. An action on the RCE follows.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

Claims 8-10, 12-14, 16-18, and 20-25 are rejected under 35 U.S.C. 102(e) as being anticipated by Lopatin et al. (PN 6,368,954, of record). Note Figures 1-9 of Lopatin et al.. Lopatin et al. discloses a method of manufacturing a multi-layered barrier metal thin film by atomic layer chemical vapor deposition comprising the steps of,

providing a substrate (200) in a reactant chamber;

providing a first chemical species (titanium, tantalum, tungsten) in the reactant chamber;

providing a second chemical species (ammonia, etc.) in the reactant chamber;, wherein the first and second chemical species react to deposit a barrier metal thin film of a metal nitride (401) on the substrate by atomic layer chemical vapor deposition;

providing a third chemical species in the reactant chamber;

providing a fourth chemical species in the reactant chamber, wherein the third and fourth chemical species react to deposit a second layer of the barrier metal thin film of a second metal nitride directly on the first layer by atomic layer chemical vapor deposition, wherein the second metal nitride is different in thickness from the first metal nitride,

wherein the barrier metal thin film deposited on the substrate defines a thickness of less than 100 Angstroms. Note Col. 4, line 37 to Col. 5, line 40.

With regard to claims 9 and 17, Lopatin et al. discloses the method further comprising depositing a thin copper film (402,403,404) on the barrier metal thin film.

With regard to claim 10, Lopatin et al. discloses the thickness of the barrier metal thin film is equal to an atomic thickness of the metal nitride. Note Col. 4, lines 42-53.

With regard to claims 12, 18 and 24, Lopatin et al. discloses the barrier metal thin film and the second barrier metal thin film are each chosen from the group consisting of TiN, TaN, W, WN and Si_3N_4. Note Col. 4, line 54 to Col. 5, line 39.

With regard to claim 13, Lopatin et al. discloses the substrate comprises a trench having a bottom surface and a side wall, and wherein the barrier metal thin film is deposited on the bottom surface and the sidewall by atomic layer chemical vapor deposition such that the barrier metal thin film defines a blocking diffusion characteristic which is the same on the side wall and the bottom surface

With regard to claim 16, Lopatin et al. discloses the method further comprising providing a fifth chemical species in the reactant chamber and providing a sixth chemical species in the reactant chamber, wherein the fifth and sixth chemical species react to deposit a third barrier metal thin film of a metal nitride on the barrier metal thin film by atomic layer chemical vapor deposition. Note Col. 4, lines 42-53.

With regard to claim 20, Lopatin et al. discloses the first chemical species comprises a metal halide and the second chemical species comprises a nitrogen containing gas. Note Col. 4, line 54 to Col. 5, line 28.

With regard to claim 25, Satta et al. discloses the method further comprising depositing a third layer of the first metal nitride on the second layer by atomic layer chemical vapor deposition, and depositing a fourth layer of the second metal nitride on the third layer by atomic layer chemical vapor deposition such that the multi-layered barrier metal thin film comprises alternating layers of the first and second metal nitride.

3. Claims 8-10, 12-18 and 20-25 are rejected under 35 U.S.C. 102(e) as being anticipated by Satta et al. (PN 6,391,785, of record). Note Figures1-3 of Satta et al..

Satta et al. discloses a method of manufacturing a multi-layered barrier metal thin film by atomic layer chemical vapor deposition comprising the steps of,

providing a substrate in a reactant chamber;

providing a first chemical species (titanium, tantalum, tungsten, etc.) in the reactant chamber;

providing a second chemical species (nitrogen, etc.) in the reactant chamber, wherein the first and second chemical species react to deposit a first layer of a barrier metal thin film of a first metal nitride (26) on the substrate by atomic layer chemical vapor deposition;

providing a third chemical species in the reactant chamber;

providing a fourth chemical species in the reactant chamber, wherein the third and fourth chemical species react to deposit a second layer of the barrier metal thin film of a second metal nitride directly on the first layer by atomic layer chemical vapor deposition, wherein the second metal nitride is different in thickness from the first metal nitride,

wherein the barrier metal thin film deposited on the substrate defines a thickness of less than 100 Angstroms. Note Col. 7, line 23 to Col. 10, line 46.

With regard to claims 9 and 17, Satta et al. discloses the method further comprising depositing a thin copper film (not shown, 18) on the barrier metal thin film. Note Col. 13, lines 38 to Col. 14, line 5.

With regard to claim 10, Satta et al. discloses the thickness of the barrier metal thin film is equal to an atomic thickness of the metal nitride.

With regard to claims 12, 18 and 24, Satta et al. discloses first layer of the barrier metal thin film and the second layer of the barrier metal thin film are each chosen from the group consisting of TiN, TaN, W, WN and Si_3N_4.

With regard to claim 13, Satta et al. discloses the substrate comprises a trench having a bottom surface and a side wall, and wherein the barrier metal thin film is deposited on the bottom surface and the sidewall by atomic layer chemical vapor deposition such that the barrier metal thin film defines a blocking diffusion characteristic which is the same on the side wall and the bottom surface

With regard to claim 15, Satta et al. discloses the method is conducted at a temperature in a range of 300 to 600C, at a pressure in a range of 0.001 to 1.0 torr, and wherein each atomic layer

chemical vapor deposition step is conducted for a time period in a range of 0.4 to 5.0 seconds. Note Tables 1 and 2, Col. 11, line 65 to Col. 12, line 11.

With regard to claim 16, Satta et al. discloses the method further comprising providing a fifth chemical species in the reactant chamber and providing a sixth chemical species in the reactant chamber, wherein the fifth and sixth chemical species react to deposit a third barrier metal thin film of a metal nitride on the barrier metal thin film by atomic layer chemical vapor deposition. Note Col. 10, lines 35-46

With regard to claim 20, Satta et al. discloses the first chemical species comprises a metal halide and the second chemical species comprises a nitrogen containing gas.

With regard to claim 25, Satta et al. discloses the method further comprising depositing a third layer of the first metal nitride on the second layer by atomic layer chemical vapor deposition, and depositing a fourth layer of the second metal nitride on the third layer by atomic layer chemical vapor deposition such that the multi-layered barrier metal thin film comprises alternating layers of the first and second metal nitride.

4. Claims 21-25 are rejected under 35 U.S.C. 102(e) as being anticipated by Leem (PN 6,284,646, of record). Note Figure 2C of Leem.

Leem discloses a method of manufacturing a multi-layered barrier metal thin film by atomic layer chemical vapor deposition comprising the steps of,

providing a substrate (17) in a reactant chamber;

depositing a first layer of a first metal nitride (22) on the substrate by atomic layer chemical vapor deposition; and

depositing a second layer of a second metal nitride (26) directly on the first layer by atomic layer chemical vapor deposition;

wherein the first metal nitride is different from the second metal nitride. Note Col. 5, line 15 – Col. 6, line 65.

With regard to claim 22, Leem discloses the method further comprising depositing a third layer of a third metal nitride on the second layer by atomic layer chemical vapor deposition, wherein the third metal nitride is different from the first and the second metal nitrides. Note Col. 5, line 15 – Col. 6, line 65.

With regard to claim 23, Leem discloses the multi-layered barrier metal thin film (26) deposited on the substrate defines a thickness of less than 100 Angstroms. Note Col. 6, lines 45-46.

With regard to claim 24, Leem discloses the first and the second metal nitrides are each chosen from the group consisting of TiN, TaN, W, WN and Si_3N_4.

With regard to claim 25, Leem discloses the method further comprising depositing a third layer of the first metal nitride on the second layer by atomic layer chemical vapor deposition, and depositing a fourth layer of the second metal nitride on the third layer by atomic layer chemical

vapor deposition such that the multi-layered barrier metal thin film comprises alternating layers of the first and second metal nitrides. Note Col. 5, line 15 – Col. 6, line 65.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 15 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin et al. (PN 6,368,954, of record).

Lopatin et al. discloses all of the claimed limitations except the time period for conducting each atomic layer in the range of 0.4 to 5.0 seconds and the thickness of the first and second films. Although Lopatin et al. does not teach the exact the time period and the thickness, as that claimed by Applicants, however, it would have been obvious to one having ordinary skill in the art at the time the invention was made to form the barrier during the time period and having the desire thickness, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

6. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Satta et al. (PN 6,391,785, of record).

Satta et al. discloses all of the claimed limitations except the time period for conducting each atomic layer in the range of 0.4 to 5.0 seconds and the thickness of the first and second films. Although Satta et al. does not teach the exact the time period and the thickness, as that claimed by Applicants, however, it would have been obvious to one having ordinary skill in the art at the time the invention was made to form the barrier during the time period and having the desire thickness, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Response to Arguments

7. Applicant's arguments filed 04/29/03 have been fully considered but they are not persuasive.

It is argued, at page 4 of the Remarks, that Lopatin et al. does not disclose the second metal nitride is different from the first metal nitride. This argument is not convincing because the claimed language does not state "different" in what (thickness, material, composition, etc.). As in this case, Lopatin et al. discloses, at Col. 4, line 54 – Col. 5, line 39, the second metal nitride is different in thickness from the first metal nitride.

It is argued, at page 4 of the Remarks, that Lopatin et al. does not disclose the second metal nitride is positioned "directly" on a first nitride layer. This argument is not convincing because Lopatin et al. discloses, at Col. 4, line 54 – Col. 5, line 39, the primary feature of the ALD process is the formation of the barrier layer 401 by a multiplicity of process cycles in which each cycle produces essentially an equivalent monolayer of the barrier material. Therefore, if the first

metal nitride has the thickness of x cycle, then the second metal nitride can have the thickness of 2x cycles, directly on the first metal nitride.

It is argued, at page 5 of the Remarks, that Satta et al. does not disclose the second metal nitride is different from the first metal nitride. This argument is not convincing because the claimed language does not state "different" in what (thickness, material, composition, etc.). As in this case, Satta et al. discloses, at Col. 7, line 23 – Col. 10, line 46, the second metal nitride is different in thickness from the first metal nitride.

It is argued, at page 5 of the Remarks, that Satta et al. does not disclose the second metal nitride is positioned "directly" on a first nitride layer. This argument is not convincing because Satta et al. discloses, at Col. 7, line 23 – Col. 10, line 46, the barrier layer 26 is built up in sepqential steps wherein each step involves the formation of one atomic layer. Satto further discloses each cycle is repeated at least about 10 or 20 times. Therefore, if the first metal nitride has the thickness of x cycle, then the second metal nitride can have the thickness of 2x cycles, directly on the first metal nitride.

It is argued, at pages 5 – 6 of the Remarks, that Leem does not disclose the second metal nitride is different from the first metal nitride. This argument is not convincing because Leem discloses, at Col. 5, line 15 – Col. 6, line 65, the second metal nitride (26) (W-N, Ti-Si-N, etc.) is different from the first metal nitride (22) (Ta-N, Ta-Si-N, etc.).

It is argued, at pages 5 – 6 of the Remarks, that Leem does not disclose the second metal nitride is positioned "directly" on a first nitride layer. This argument is not convincing because Leem disclose the second metal nitride (26) is positioned "directly" on a first nitride layer (22). Note that the phrase "directly on" does not necessarily mean "directly in contact" or "in physical contact with".

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hung K. Vu whose telephone number is (571) 272-1666. The examiner can normally be reached on Mon-Thurs 6:00-3:30, alternate Friday 7:00-3:30, Eastern Time.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on (571) 272-1732. The Central Fax Number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Vu

January 24, 2005

Hung Vu

Primary Examiner